Report for 2002NH4B: Effects of Land Use on Water Quality in a Changing Landscape

- Conference Proceedings:
  - J. Schloss, N. Lambert and F. Rubin. 2002. GIS Outreach and Training for Decision-makers and Educators to Ensure Data to Action in Local Watersheds. National Water Quality Monitoring Conference. Madison, Wisconsin , May 2002. (On web and CD).
- Other Publications:
  - J. Schloss 2002 Squam Lakes Watershed Study- Water and Nutrient Budget. UNH Center for Freshwater Biology/ UNH WRRC/ UNH Cooperative Extension.
  - R. Craycraft and J. Schloss. 2002. Lakes Lay Monitoring Program Annual Report for 2001. A series of more than 50 individual lake reports distributed to lake associations, towns, conservation and planning commissions, and state agencies.
  - Protecting a Postcard-Perfect Lake (Chocorua) Volunteer Monitor newsletter co-wrote with Eleanor Ely.

Report Follows:

Objectives:

1- The continued collection and analysis of long-term water quality data in selected watersheds.
2- The dissemination of the results of the analysis to cooperating agencies, water managers, educators and the public on a local, statewide and regional basis.
3- To offer undergraduate and graduate students the opportunity to gain hands-on experience in water quality sampling, laboratory analysis, data management and interpretation.
4- To further document the changing water quality in the College Brook Watershed (at UNH) in the face of land use changes and management efforts.
5- To document the effectiveness of constructed BMPs in the Chocorua Lake Watershed
6- To finalize the data analysis of the Squam Lakes Water Nutrient Budget.
7- To determine the next steps for further analysis of long-term data sets.

Methodology

Ongoing sampling of College Brook has been done on a monthly basis and during storm events. Parameters measured include: dissolved oxygen, pH, temperature, specific conductivity, total suspended solids, total dissolved nitrogen, nitrate, phosphate, sulfate, chloride, silica, dissolved organic carbon, and base cations (Ca, Mg, Na, and K).

Lake and stream monitoring through the LLMP generally involved a minimum of monthly sampling from spring runoff through lake stratification, and weekly to bi-weekly sampling from stratification until fall overturn. Water clarity, chlorophyll a, acid neutralizing capacity, disoolved organic color, dissolved oxygen and nutrients (total N, total P and nitrate) was the default suite of parameters measured for lakes while nutrients, turbidity, color and flow were the parameters of choice for the lake tributary work. On occasion, student field teams traveled to join the volunteer monitors to perform quality assurance checks and do more in-depth analysis and lake profiling. Land cover changes to study subwatersheds were documented on our established GIS data base and new management practices or conservation efforts were also documented. Particular emphasis was placed in the Chocorua, Ossippee River and on the Squam Lakes watersheds this year.

This project was coordinated from the University of New Hampshire, which supplied the office and laboratory space (analytical and computer). The Center for Freshwater Biology Analytical Water Quality Laboratory has a Quality Assurance Project Plan for surface water analysis on file with the US Environmental Protection Agency Region 1 Office (EPA New England). Besides nutrient analysis (Total Phosphorus, Total Nitrogen, Nitrate), other water quality measurements included chlorophyll a, dissolved oxygen, dissolved Co2, acid neutralizing capacity, specific conductivity, pH, ORP, turbidity, water clarity, iron and E.coli. The Water Quality Analysis Laboratory of the NH WRRC uses automated flow injection analysis, ion chromatography, and high temperature combustion techniques for water quality analysis.

UNH Cooperative Extension and the Natural Resource Department provided vehicles for travel for PI's, students and interns at a cost (mileage) basis. A dedicated GIS PC NT workstation was provided for use including Arc/Info and ArcView Software, ArcView Extensions: Spatial Analyst, 3D Analyst, Image Analysis and ArcPress. This was used in addition to other data input PC stations, laser printers and a large format (36" wide) ink jet plotter that was made available for the project.

The project utilized an extensive GIS database for the study subwatersheds created through previous WRRC funding to the PI. Updated and additional GIS data including a new land cover dataset for 2000 as well as an index of impervious surface cover was made available through the UNH Complex Systems Research Center which manages the NH GRANIT statewide GIS data depository. The extensive data directory contains statewide GIS data layers (usually at 1:24,000 scale) including hydrology, geology, soils, National Wetlands Inventory, land-use, land cover, and digital elevation models. Also available are Landsat Thematic Mapper, SPOT Panchromatic and digital orthophoto imagery.

Principal Findings and Significance

Comparisons between data collected in 1991 and 2000-present have indicated that overall water quality has improved in College Brook with the closing of the UNH incinerator and greater

ecological awareness on campus. Recent water quality analysis (2000-2003) indicates that the drought of 2001 has a significant effect on water quality. It was the third driest year for the state of New Hampshire for 1895-2003 and water chemistry indicated that the health of the stream was at its lowest for some parameters (TDN, nitrate, ammonium, BOD, etc…). Construction on campus has also likely had an impact on stream quality and in 2001 construction occurred in close proximity to the stream in the watershed. Construction accidents (i.e. - water main break) caused large runoff discharges into College Brook and likely had effects on the stream, which further complicates the picture. Further analysis of the data and continued monitoring of College Brook is scheduled to continue. The College Brook web site can be viewed at http://www.wrrc.unh.edu/collegebrook/college_brook.htm

Ongoing collection of ambient water quality data across the state continues. We added new sites for our statewide lake study.). In 2002 we saw an additional 309 samples collected, a 12% increase over 2001 (in chlorophyll and color samples which all participants measure) with a greater than 36% increase occurring in the Lakes Region. In addition, as this year's project goals also including an increase in tributary sampling in particular, we added an additional 293 Total Phosphorus samples in 2002 over 2001. All but 18 of these were from Lakes Region participants. This is particularly impressive given that dry summer conditions did not allow for many tributary sampling opportunities on smaller streams for the addition of 4 new lakes and a river watershed, and the expansion of programs on 12 other lakes with the addition of 21 new or reactivated lake sampling sites and 32 tributary sites (Table 1). It also facilitated the training of 22 new volunteer monitors.

TABLE 1: Program Expansion

Lake/River	Association/Sponsors	Town(s)
New Programs Initiated in 2002:		
Burns Pond	UNH Cooperative Extension and Coos Cons. District	Whitefield
Cherry Pond	UNH Cooperative Extension and Coos Cons. District	Jeffreson
Durand Pond	UNH Cooperative Extension and Coos Cons. District	Randolph
Martin Meadow Pond	UNH Cooperative Extension and Coos Cons. District	Lancaster
Saco River**	Green Mountain Conservation Group	Ossipee, Freedom, Tamworth, Sandwich
Existing Programs Expanded (new monitoring sites) in 2002:		
Big Dan Hole Pond	Dan Hole Pond Watershed Assn.	Tuftonboro, Ossipee
Bow Lake**	Bow Lake Campowners Assn.	Strafford, Northwood
Lake Chocorua**	Lake Chocorua Ass'n.	Tamworth, Albany
Great East Lake**	Great East Lake Association	Wakefield
Lake Kanasatka**	Lake Kanasatka Watershed Assn.	Moultonboro
Little Dan Hole Pond	Dan Hole Pond Watershed Assn.	Ossipee
Newfound Lake**	Newfound Lake Region Assn.	Alexandria, Bristol, Bridgewater, Hebron
Ossipee Lake, Broad Bay	Broad Bay Association	Ossipee, Freedom
Squam Lakes**	Squam Lakes Association	Ashland, Holderness, Sandwich, Center Harbor
Lake Winnipesaukee, Moultonboro Bay	LWA* and Tuftonboro Assn	Tuftonboro, Moultonboro
Lake Winnipesaukee, Meredith Bay	LWA and Meredith Rotary Club	Meredith
Lake Winnipesaukee, Wolfeboro Bay	LWA and Town of Wolfeboro	Wolfeboro
Lake Winnipesaukee, Green's Basin	LWA and Town of Wolfeboro	Moultonboro
Lake Winnipesaukee, Broads	LWA	Guilford, Alton

* LWA= Lake Winnipesaukee Association
** Tributary monitoring expanded or initiated

The Lake Chocorua BMP Evaluation Study continued to disclose that a significant reduction in the phosphous loading was due to the road drainage mitigation techniques. The combination of the use of plunge pools, diversions to settling areas and a large collecting swale reduced loadings during storm events by 82-94% while control sites only varied by plus or minus 10%. The P

concentration range from the runoff was again reduced significantly (pre-range of 34 to 281ppb post range of 13 to 32 ppb). Further monitoring was initiated to capture spring runoff and additional storm events but draught conditions limited the additional data collection. It is expected that the upcoming spring melt of 2003 will exhibit more “typical” spring runoff conditions. Preliminary testing of periphyton samplers with corresponding miniature data loggers for compensating for temperature and light conditions as part of this prject was used as the basis to secure EPA NPS program funding to continue investigating the wetland effects on water and nutrient flux as part of our landscape level analysis.

Analysis of the Squam Lake Watershed nutrient budget disclosed that subwatersheds with construction activity or active agriculture were the largest contributor of phosphorous on an aerial (load per hectare) basis. Highest loadings on a volumetric basis were typical of beaver flows and wetland or ponded drainage during certain times of the year (although many wetlands shunyed nutrients until the end of the growing season. Also, unlike Lake Chocorua, septic systems played a significant role in nutrient loading during the summer season. An analysis of landscape features and nutrient loadings is currently underway as a dissertation research study.

Students involved or funded (#, undergrad, Masters, and PhD)

Shane Bradt- -	Zoology	Grad student (PhD)	Summer/Fall/Winter
Autumn Carlson	Environmental Conservation	Senior	Summer/Fall
William Clark	Environmental Conservation	Senior	Summer/Fall
Robert Craycraft	Water Resources	Grad Student (MS)	Summer/Fall/Winter
Gregg Decelles	Marine & Freshwater Bio	Sophomore	Summer
Melissa McCartney	Forestry	Senior	Fall/Winter
Juliette Nowak	Zoology	Grad student	Summer
Lydia Pitkin	History	Sophomore	Fall/Winter
Kirsten Pulkkinen	Environmental Conservation	Senior	Summer
Santhana Souksamrane	Undeclared	Freshman	Fall/Winter
Amy Surprenant	Business	Sophomore	Fall/Winter

Total of 8 undergraduate, 2 masters and 1 doctoral student(s) directly supported. Indirect support (equipment loan, analytical services, field support) given to an additional 6 undergraduates and 3 MS students.

In addition: water quality and GIS data were used in:
WARM 604- Watershed Hydrology -11 students
Zoology/Botany 719/819- Field Limnology- 18 students
Biology/Zoology 896- Multidisciplinary Lake Management- 5 students
WARM 721-Ecology of Polluted Waters- 16 students
NSF Funded: Project Lake Watch

Presentations by Jeff Schloss covering all or parts of study or data base:

North American Lake Management Society/EPA/ NC Lake Management Society.	Southeastern Lake Management Conference	March 2002 Winston-Salem, NC	Invited plenary: "Successful Watershed Stewardship-Volunteers make it happen." and technical presentation: "In-vivo Chlorophyll Fluorescence: The good, the bad and the algae".
University of Maine Water Resources Research Center	Maine Water Conference	May 2002 Augusta, ME	Invited Plenary: "GIS Applications for Inland Watershed Management"
National Water Quality Monitoring Council	Third Annual Water Quality Monitoring Conference	May 2002 Madison, WI	Presented: GIS Outreach and Training for Decision-makers and Educators to Ensure Data to Action in Local Watersheds".
New England Chapter-North American Lake Management Society (NALMS)	2002-New England Lakes Conference	June 2002 Springfield, MA	Presented Workshop: "GIS Watershed Inventories- A guided Tour". Presented NALMS welcome for opening plenary.
New Hampshire Lakes Association	Annual Lakes Congress	June 2002 Manchester, NH	Invited panel speaker: "Carrying Capacity of NH Lakes".
Mount Washington Hotel	Centennial Celebration	August 2002	Invited to present: "Global Change in Climate, Water and Population. What it may mean for New England".
Alberta Lake Management Society	2002 Annual Meeting/Workshop	September 2002 Red Deer, Alberta, Canada	Invited to present plenary: "Successful Watershed Stewardship-Volunteers make it happen."

North American Lake Management Society/EPA/.	International Lake Management Symposium	November 2002 Anchorage, AK	Invited plenary speaker and technical presentation: “In-vivo Chlorophyll Fluorescence: The good, the bad and the algae”.
USDA CSREES Regional Water Quality Working Group	2002 Annual Meeting	December 2002 Warwick, RI	Invited presenter: “Spatial Technology Training for Water Resources Protection”